

CLAIMS:

INSB¹⁰ 1. An electron-emitting device comprising a laminate comprising an insulating layer held between a pair of electrodes opposing each other, wherein an
5 electron-emitting region insulated from said electrodes is formed at a side end surface of the insulating layer formed at the part at which the electrodes oppose each other, and electrons are emitted from said electron-emitting region by applying
10 a voltage between said electrodes.

2. The electron-emitting device of Claim 1, wherein a pair of said electrodes, opposing each other at each end portion of the electrodes, hold said
15 insulating layer without any overlap of said electrodes.

3. The electron-emitting device of Claim 1, wherein said electron-emitting region comprises a
20 laminate comprising an insulating layer and a layer of an electron-emitting material.

4. The electron-emitting device of Claim 3, wherein said electron-emitting material is selected
25 from the group consisting of borides, carbides, nitrides, metals, metal oxides, semiconductors, and

1 carbon.

5. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises at
5 least two kinds of different materials.

6. The electron-emitting device of Claim 4,
wherein said electron-emitting material is selected
from the group consisting of Nb, Mo, Rh, Hf, Ta, W,
10 Re, Ir, Pt, Ti, Au, Ag, Cu, Cr, Al, Co, Ni, Fe, Pb,
Pd, Cs and Ba.

7. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises a
15 metal oxide selected from the group consisting of
 In_2O_3 , SnO_2 , BaO , MgO and Sb_2O_3 .

8. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises fine
20 particles of Pd or SnO_2 .

9. The electron-emitting device of Claim 1,
wherein said electron-emitting region comprises a
layer formed by incorporating an electron-emitting
25 material in the insulating layer in a dispersed state.

1 carbon.

5. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises at
5 least two kinds of different materials.

6. The electron-emitting device of Claim 4,
wherein said electron-emitting material is selected
from the group consisting of Nb, Mo, Rh, Hf, Ta, W,
10 Re, Ir, Pt, Ti, Au, Ag, Cu, Cr, Al, Co, Ni, Fe, Pb,
Pd, Cs and Ba.

7. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises a
15 metal oxide selected from the group consisting of
 In_2O_3 , SnO_2 , BaO, MgO and Sb_2O_3 .

8. The electron-emitting device of Claim 4,
wherein said electron-emitting material comprises fine
20 particles of Pd or SnO_2 .

9. The electron-emitting device of Claim 1,
wherein said electron-emitting region comprises a
layer formed by incorporating an electron-emitting
25 material in the insulating layer in a dispersed state.

1 10. The electron-emitting device of Claim 9,
wherein said electron-emitting material is selected
from the group consisting of borides, carbides,
nitrides, metals, metal oxides, semiconductors, and
5 carbon.

11. The electron-emitting device of Claim 10,
wherein said electron-emitting material comprises at
least two kinds of different materials.

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12. The electron-emitting device of Claim 10,
wherein said electron-emitting material is selected
from the group consisting of Nb, Mo, Rh, Hf, Ta, W,
Re, Ir, Pt, Ti, Au, Ag, Cu, Cr, Al, Co, Ni, Fe, Pb,
15 Pd, Cs and Ba.

13. The electron-emitting device of Claim 10,
wherein said electron-emitting material comprises a
metal oxide selected from the group consisting of
20 In_2O_3 , SnO_2 , BaO , MgO and Sb_2O_3 .

14. The electron-emitting device of Claim 10,
wherein said electron-emitting material comprises fine
particles of Pd or SnO_2 .

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15. The electron-emitting device of Claim 1,

1 wherein an electron-emitting material is arranged on
the side end surface of said insulating layer.

16. The electron-emitting device of Claim 15,
5 wherein said electron-emitting material is selected
from the group consisting of borides, carbides,
nitrides, metals, metal oxides, semiconductors, and
carbon.

10 17. The electron-emitting device of Claim 16,
wherein said electron-emitting material comprises at
least two kinds of different materials.

18. The electron-emitting device of Claim 16,
15 wherein said electron-emitting material is selected
from the group consisting of Nb, Mo, Rh, Hf, Ta, W,
Re, Ir, Pt, Ti, Au, Ag, Cu, Cr, Al, Co, Ni, Fe, Pb,
Pd, Cs and Ba.

20 19. The electron-emitting device of Claim 16,
wherein said electron-emitting material comprises a
metal oxide selected from the group consisting of
 In_2O_3 , SnO_2 , BaO , MgO and Sb_2O_3 .

25 20. The electron-emitting device of Claim 16,
wherein said electron-emitting material comprises fine

1 particles of Pd or SnO_2 .

21. The electron-emitting device of Claim 1,
wherein the one or both of a pair of said electrodes
5 are in a multiple layer constitution.

22. The electron-emitting device of Claim 21,
wherein at least one layer of the multiple layers is
made of a material not readily damaged by ion
10 sputtering.

23. The electron-emitting device of Claim 22,
wherein said material comprises a high-melting
material selected from the group consisting of W,
15 LaB_6 , carbon, TiC and TaC .

24. The electron-emitting device of Claim 21,
wherein at least one layer of said multiple layers
comprises a material exhibiting a low work function.
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25. The electron-emitting device of Claim 24,
wherein said material is selected from the group
consisting of SnO_2 , In_2O_3 , BaO , LaB_6 , Cs , and CsO .

25 26. The electron-emitting device of Claim 21,
wherein at least one layer of said multiple layers

1 formed at the part at which the electrodes oppose each other;

and electrons are emitted by application of a voltage between said electrodes.

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30. An electron-emitting device comprising;
a pair of opposing electrodes, holding there-
between a laminate comprising a layer in which an
electron-emitting material is dispersed and an insulating
10 layer; and an or the electron-emitting material provided
on the side wall surface of the insulating layer,
formed at the part at which the electrodes oppose each
other; where electrons are emitted by application of
a voltage between said electrodes.

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31. An electron-emitting device comprising;
a pair of opposing electrodes, holding
therebetween an insulating layer containing an
electron-emitting material in a dispersed state; and
20 an or the electron-emitting material provided
on the side wall surface of the insulating layer,
formed at the part at which the electrodes oppose each
other; where electrons are emitted by application of

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1 comprises a material having a high electrical
conductivity.

27. The electron-emitting device of Claim 26,
5 wherein said material is selected from the group
consisting of Ag, Al, Cu, Cr, Ni, Mo, Ta, W, and an
alloy of any of these.

28. An electron-emitting device comprising a
10 laminate comprising an insulating layer interposing a
layer in which an electron-emitting material is
dispersed, and held between a pair of opposing
electrodes, wherein said electrodes do not come into
contact with the layer in which an electron-emitting
15 material is dispersed; an end of said layer in which
the electron-emitting material is dispersed is
positioned at the side end surface of the insulating
layer, formed at the part at which the electrodes
oppose each other; and electrons are emitted by
20 application of a voltage between said electrodes.

29. An electron-emitting device comprising a
laminate comprising an insulating layer containing an
electron-emitting material in a dispersed state and
25 held between a pair of opposing electrodes, wherein;
a side end surface of the insulating layer is

1 a voltage between said electrodes.

32. An electron-emitting device comprising a
device structure in which an insulating layer is
5 formed between opposing electrodes, and fine particles
are arranged inside the layer of said insulating layer
in a dispersed state.

33. The electron-emitting device of Claim 32,
10 having the structure in which said fine particles are
completely included into said insulating layer.

34. The electron-emitting device of Claim 32,
having the structure that any of said fine particles
15 is partly included into and partly exposed from said
insulating layer.

35. The electron-emitting device of Claim 32,
wherein said fine particles is composed of a substance
20 selected from the group consisting of borides,
carbides, nitrides, metals, metal oxides,
semiconductors, and carbon.

36. The electron-emitting device of Claim 32,
25 wherein said fine particles are dispersed between the
electrodes by coating.

1 37. The electron-emitting device of Claim 32,
wherein said fine particles are dispersed between the
electrodes by vacuum deposition.

5 38. The electron-emitting device of Claim 32,
wherein said fine particles are dispersed by thermal
decomposition of an organic metal compound.

 39. The electron-emitting device of Claim 32,
10 having the device structure in which the insulating
layer is formed between the opposing electrodes on a
substrate, and said fine particles are arranged inside
the layer of said insulating layer in a dispersed
state.

15 40. The electron-emitting device of Claim 39,
wherein said opposing electrodes are formed on the
insulating layer on a substrate, and said fine
particles contained in said insulating layer are those
20 obtained by dispersing the fine particles between said
electrodes followed by baking.

 41. The electron-emitting device of Claim 40,
wherein said insulating layer comprises a low-melting
25 glass.

1 42. The electron-emitting device of Claim 40,
wherein said insulating layer has a film thickness of
from several ten angstroms to several ten microns.

5 43. A method of preparing an electron-emitting
device, comprising a step of forming electrodes on a
substrate, and a step of coating a mixture of fine
particles and an insulating material with a solvent
between said electrodes, and a step of baking to form
10 an insulating layer containing said fine particles.

44. A method of preparing an electron-emitting
device, comprising a step of forming electrodes on a
substrate, a step of dispersing fine particles between
15 said electrodes, and a step of forming an insulating
layer on said fine particles having been dispersed.

45. The method of Claim 44, wherein said
insulating layer is a layer comprised of a substance
20 selected from the group consisting of an oxide, a
nitride, a carbide or an organic polymer.

46. The method of Claim 45, wherein said
insulating layer has a film thickness of from several
25 ten angstroms to several ten microns.

1 47. The electron-emitting device of Claim 32,
comprising a substrate comprising a porous glass in
which a metal or a metal oxide is deposited.

5 48. The electron-emitting device of Claim 32,
comprising a colored glass containing metal colloid
fine particles.

10 49. A method of preparing an electron-emitting
device, comprising a step of bringing fine particles
in an insulating layer to be completely included into
the insulating layer, and a step of etching said
insulating layer to bring the completely included fine
particles partly exposed from the insulating layer.

15 50. A method of preparing an electron-emitting
device, comprising a step of coating on a substrate an
insulating layer containing fine particles followed by
baking, and a step of forming electrodes on said
20 insulating layer.

25 51. An electron-emitting device comprising the
device structure that a semiconductor layer is formed
between opposing electrodes, and fine particles are
arranged inside the layer, or on the layer, of said

1 semiconductor layer in a dispersed state.

52. The electron-emitting device of Claim 51,
having the structure that said fine particles are
5 completely included into said semiconductor layer.

53. The electron-emitting device of Claim 51,
having the structure that said fine particles are
partly contained in said semiconductor layer and
10 partly exposed therefrom.

54. The electron-emitting device of Claim 51,
wherein said fine particles are made of a substance
selected from the group consisting of borides,
15 carbides, nitrides, metals, metal oxide,
semiconductors, and carbon.

55. The electron-emitting device of Claim 51,
wherein said fine particles are dispersed between said
20 electrode by coating.

56. The electron-emitting device of Claim 51,
wherein said fine particles are dispersed between said
electrode by vacuum deposition.

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57. The electron-emitting device of Claim 51,

1 wherein said fine particles are dispersed by thermal
decomposition of an organic metal compound.

58. The electron-emitting device of Claim 51,
5 having the device structure in which the electrodes
are formed on a substrate, the semiconductor layer is
formed between said electrodes, and the fine particles
are arranged inside the layer, or on the layer, of
said semiconductor layer in a dispersed state.

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59. A method of preparing electron-emitting
device, comprising a step of forming electrodes on a
substrate, and a step of coating between said
electrodes a fine particle dispersion containing an
15 organic binder followed by baking to effect dispersion
of the fine particles.

60. The method of Claim 59, wherein said
organic binder is selected from the group consisting
20 of a butyral resins, acryl resins, vinyl chloride-
vinyl acetate copolymers, phenol resins, nylons,
polyesters and urethanes.

61. A method of preparing electron-emitting
25 device, comprising a step of forming a semiconductor
layer on a substrate, a step of forming electrodes on

1 said semiconductor layer, and a step of dispersing
fine particles between said electrodes.

62. The method of Claim 61, wherein said
5 semiconductor layer comprises a layer comprised of an
amorphous silicon semiconductor, a crystallized
silicon semiconductor, or a compound semiconductor.

63. The method of Claim 61, wherein said
10 semiconductor layer has a film thickness of from 50
angstroms to 10 μm .

64. A method of preparing an electron-emitting
device, comprising a step of bringing fine particles
15 to be completely included into a semiconductor layer,
and a step of etching said fine particles having been
completely included into it to bring them to partly
expose from said semiconductor layer.

20 65. An electron-emitting device comprising
electrodes having minute spacing, between which at
least two kinds of fine particles of different
materials are arranged.

25 66. The electron-emitting device of Claim 65,
wherein said different materials comprise materials

1 having different conductivity.

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